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Brad Sherbuck - Secretary to Gavin N. Manning 6/12/03

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Application No. 10/051,016
Amendment dated 12 June 2003
Reply to Office action of 24 October 2002

IN THE UNITED STATES PATENT & TRADEMARK OFFICE
Patent Examining Operations
Patent Application

Inventor(s): GELBART, Daniel
Title: **METHOD FOR IMAGING A CONTINUOUSLY MOVING OBJECT**
Serial No.: 10/051,016
Filed: 22 January 2002
Examiner: Andrew T. SEVER Art Unit: 2851
Date: 12 June 2003
Docket No.: C525 0221

To: Assistant Commissioner for Patents
Washington, D.C.
20231

Dear Sir:

AMENDMENT

Responsive to the office action mailed 24 October 2002, please amend this application as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 10 of this paper.

Remarks begin on page 12 of this paper.

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Amendments to the Specification

Please replace the first full paragraph on page 1 with the following rewritten paragraph:

The invention relates to imaging, and specific embodiments of the invention relate more particularly to ~~the elimination of motion blur when~~ projecting stationary images ~~on~~ onto a moving object.

Please replace the paragraph spanning pages 1 and 2 with the following rewritten paragraph:

In various industries employing photo-lithography, there is a desire to use two-dimensional light valves to project ~~an image on~~ images onto ~~a~~ moving ~~object~~ objects. ~~The~~ One typical use ~~is~~ for such image projection involves projecting a UV image in order to expose a UV sensitive material, such as photoresist or photopolymer. ~~The~~ One advantage of two-dimensional light valves ~~over a laser~~ (as compared to lasers) is that low brightness sources, such as arc lamps, can be used with light valves. The best known device using a light valve to project an image is the video projector, which is commonly used to project video and computer generated images ~~on~~ onto a screen. ~~It is an object of this invention to utilize a low cost and readily available video projector as means of projecting images on moving objects.~~ Prior art systems for projecting ~~on~~ images onto moving objects use one of the following methods:

a) ~~A~~ Using a step-and-repeat ~~motion of the object, thus~~ technique, wherein the object is stepped over a certain movement and then is held stationary at the moment of imaging. The stepping and imaging may then be repeated a number of times to complete the image;

b) Synchronizing the image to the motion of the object by shifting the data in the light valve. ~~(For~~ See, for example, U.S. Patents 5,049,901; 5,208,818; and 5,132,723~~)~~;

c) Moving both the light valve and the object at the same time. ~~(For~~ See, for example, U.S. Patents 5,870,176 and 6,060,224~~)~~;

d) Dividing the image into columns and using an acousto-optic modulator to synchronize the image with the motion one column at a time. ~~(For~~ See, for example, ~~see~~ U.S. Patents RE37,376E and 5,923,359).

Please replace the first and second full paragraphs on page 2 with the following rewritten paragraph:

None of ~~the above inventions allow the use of~~ these techniques involve using a stationary light valve based projector ~~which projects~~ to project a series of stationary images in a rapid sequence to image a continuously moving object. ~~The importance of this mode is that it allows the use of a low cost, off the shelf video projector as a lithographic imaging device, without requiring step-and-repeat type motion of the object or the imaging source. The main advantages of a continuous mechanical motion over a stepped motion is in a smoother, more accurate and more reliable mechanical system.~~

~~The present invention is particularly useful in the following applications. the production of printing plates (both lithographic and flexographic), the production of printed circuit boards (also known as~~

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~~"direct imaging"), the production of displays and the production of solid objects from photopolymer.~~

Please replace the paragraph spanning pages 2 and 3 with the following rewritten paragraph:

The invention uses a scanning device between ~~the~~ an image source, typically a commercial video projector, and ~~the~~ a moving object, typically a planar object which may be coated with photoresist. The scanning device allows the projector and the projected image to remain stationary while the scanning device tracks the motion of the moving object until one frame is exposed. At the end of each frame the scanning device resets to the initial position while the image source changes the image to the next frame. The process repeats itself until a complete stripe of images is recorded. For imaging in the UV, the video projector lamp and the optics ~~are~~ may be modified in order to enhance the UV output. After one stripe of images is recorded, further stripes ~~are~~ may be imaged using a conventional two-dimensional scanning method. Either stepping motion or ~~a~~ continuous helical motion can be used to scan the second dimension of the object.

Please add the following paragraph immediately after the paragraph spanning pages 2 and 3:

The invention allows the use of a low cost, off-the-shelf video projector as a lithographic imaging device, without requiring step-and-repeat type motion of the object or the imaging source. One advantage of a continuous mechanical motion over a stepped motion is in a smoother, more accurate and more reliable mechanical system. The present invention is particularly useful in the following applications: the production of printing plates (both lithographic and flexographic), the production of printed

circuit boards (also known as "direct imaging"), the production of displays and the production of solid objects from photopolymer.

Please replace the text under the subtitle "Brief Description of the Drawings" with the following rewritten text:

Fig.1	is a schematic representation of ~~the method, as applied to imaging onto a rotary cylinder~~ a particular embodiment of the invention.
Fig. 2-a to 2-c	show a sequence of tracking one frame and switching to the next frame in the embodiment of Fig. 1.

Please replace the paragraph spanning pages 3 and 4 with the following rewritten paragraph:

Fig. 1 shows a generalized view of a commercial video projector 1. For clarity, ~~the view is shown as~~ Figure 1 depicts a cut-away view of projector 1 showing some of ~~the inside~~ its components ~~of projector 1~~ which include: a light source 2, typically a SHP type or UHP type arc lamp, a reflector 3, typically of the dichroic type, a rotating filter wheel 4, typically containing Red, Green and Blue filters, various mirrors 5 and a light valve 6. In ~~the~~ a preferred embodiment, ~~the projector 1 uses~~ light valve 6 comprises a DMD (Digital Mirror Device), such as the one made by Texas Instruments of Plano, Texas~~) as a light valve~~. The two-dimensional image formed by ~~the~~ light valve 6 is projected by lens 7 and mirror 8 onto moving object 10. In the illustrated embodiment, moving object 10 is mounted on continuously rotating drum 11. ~~The light~~ Light valve 6 forms an image 12 on ~~the~~ object 10. In one ~~application~~ particular embodiment, object 10

is a ~~light sensitive~~ lithographic printing plate comprising a light sensitive coating. ~~The light from lens 7 is reflected off mirror 8 before reaching object 10.~~ Mirror 8 is mounted on a fast galvanometer 9. ~~The off-the-shelf video project~~ Video projector 1 can be ~~modified to maximizes the spectrum of the light in the region most effective for exposing the light sensitive coating~~ configured for various light spectra. For example, if object 10 is a printing plate comprising a UV sensitive coating, it is advantageous to maximize the light output of ~~the~~ projector 1 in the UV range. ~~This is done~~ The light output of projector 1 in the UV range may be maximized by replacing the filters in filter wheel 4 with filters that transmit UV light and block visible and infra-red light ~~as well as~~ and/or changing the dichroic coating on reflector 3 to a coating which reflects UV and transmits other ~~wavelength~~ wavelengths. If reflector 3 is effective to provide a sufficient amount of UV output from projector 1, the filters on wheel 4 can be simply removed. ~~Normally it would also be required~~ In some lithographic imaging applications, it may also be desirable to replace lens 7 with a lens which is optimized for UV and ~~for a different~~ which has a desired magnification ratio. ~~For lithographic plate applications~~ When object 10 is a lithographic printing plate, lens 7 ~~should be replaced with a lens having~~ preferably has a magnification of about 1:1.

Please replace the first full paragraph on page 4 with the following rewritten paragraph:

~~The projector~~ Projector 1 is connected to a data source 13 in a conventional manner. ~~The signal 14,~~ Signal 14 is used to synchronize the projected frames (typically 60 per second) to ~~the~~ data source 13, and is also used to synchronize ~~the~~ galvanometer 9 via saw-tooth generator

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15. All components of the system ~~show~~ shown in Fig. 1 are well known, commercially available ~~and~~ components which can be purchased as complete functional assemblies. As such, no further details ~~about them are required, as they can be purchased as complete functional assemblies~~ regarding these components are provided herein.

Please replace the paragraph spanning pages 4 and 5 with the following rewritten paragraph:

The operation of the Fig. 1 system is shown in Fig. 2-a to Fig. 2-c, which should be viewed in conjunction with Fig. 1. Mirror 8 is rotated at a velocity which makes the projection of any image point on light valve 6, ~~(by the way of example point "A" on light valve 6 imaged as point A')~~ stay stationary relative to ~~the~~ moving object 10. As shown in Fig. 2-a, image point A on light valve 6 is projected onto object 10 as point A'. Projected point A' stays stationary relative to moving object 10. Since object 10 is moving at a constant velocity, ~~the~~ mirror 8 ~~has to rotate~~ preferably rotates in an approximately linear fashion. At the end of the travel of mirror 8, shown in Fig. 2-b, mirror 8 has to return as fast as possible to the starting position, as shown in Fig. 2-c. At ~~this~~ the moment between Fig. 2-b and Fig. 2-c, the image on light valve 6 is changing. ~~and a new point "B" is imaged~~ In Fig. 2-c, mirror 8 has returned to its starting position and the image on light valve 6 has changed. As shown in Figure 2-c, new image point B is projected onto object 10 as point B', again stationary relative to moving object 10. The images containing points ~~"A" and "B"~~ A and B can be ~~imagec~~ imaged in a contiguous manner on object 10 or in an overlapping manner. The degree of overlap is determined by the ratio of the image size to the range of motion of object 10 during one image (frame) interval. ~~By changing the speed~~

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~~of object 10 relative to the frame rate of projector 1 the amount of overlap is controlled.~~ The amount of overlap of successive images may be controlled by adjusting the speed of object 10 relative to the frame rate of projector 1. Obviously the image data has to be changed in data source 13 to reflect the correct overlap.

Please replace the first full paragraph on page 5 with the following rewritten paragraph:

~~It is also obvious to those versed in the art that saw-tooth~~ Saw-tooth waveform generator 15 is preferably a digital device including provisions for a look-up table. Such a table allows ~~to modify~~ modification of the profile of the saw-tooth waveform to compensate for optical distortion introduced by the scanning process. Galvanometer drivers including look-up tables are well known in the art and commercially available.

Please replace the paragraph spanning pages 5 and 6 with the following rewritten paragraph:

~~It is also obvious that the~~ The motion of object 10 ~~can~~ may be a linear motion instead of a rotary motion. A linear motion ~~is~~ may be used when scanning flat and rigid objects which cannot be wrapped around a drum. ~~An example of using the invention with linear motions is~~ Examples of applications wherein this invention may be applied to image objects that move linearly include: the imaging of glass panels for electronic displays and the imaging of printed circuit boards. When imaging a flat object moving back and forth, the imaging process can be performed in both directions by reversing the direction at the galvanometer when motion direction is reversed.

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Please replace the first full paragraph on page 6 with the following rewritten paragraph:

~~By the way of example, a Computer-to-Plate machine is described.~~ One example embodiment of the invention involves a computer-to-plate machine used in the printing industry. Projector 1 is Model 340B made by InFocus (Wilsonville, Oregon). All of the filters are removed from ~~color~~ filter wheel 4 and ~~the~~ dichroic reflector 3 is replaced with a UV-enhancing reflector optimized from 200nm to 450nm. The lens 7 is replaced with a fused-silica UV lens with a 1.04:1 magnification ratio of the double-gauss configuration. Mirror 8 and galvanometer 9 are made by Cambridge Instrument (Cambridge, Mass.), Model 6230. The frame rate used is 60Hz, with a saw-tooth rise time of 15mS and a retrace time of about 1.6mS. The saw-tooth is generated by a standard function generator. The moving object 10 is a lithographic printing plate of the projection type having a sensitivity of about 5mJ/cm2 for UV light. The projected image is 600 x 800 pixels or about 6.34mm x 8.46mm. The speed of the drum 11 is adjusted to cover 6.34mm in 15mS, giving 0.42m/S. For a plate size of 50cm x 70cm and a drum circumference of 60cm, a complete image is written in about two minutes.

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This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims

1. (Currently Amended) A method of projecting images from a two-dimensional light valve onto a continuously moving object, said method comprising ~~of~~ placing a scanning element between said light valve and said object, said scanning element synchronized with said light valve and said object in a manner ~~making~~ which makes said image stationary relative to said object.

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~~2~~. (Currently Amended) A method of projecting images from a ~~two-dimensional~~ two-dimensional light valve onto an object while relative motion exists between said light valve and said object, said method comprising ~~of~~ placing a scanning element between said light valve and said object, said scanning element making said images temporarily stationary relative to said object.

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~~3~~. (Original) A method as in claim 1, wherein said light valve is part of a video projector.

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~~4~~. (Original) A method as in claim 1 wherein said light valve is a Deformable Mirror Device.

4
~~5~~. (Original) A method as in claim 1 wherein said object is a lithographic printing plate.

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~~6~~. (Original) A method as in claim 1 wherein said object is a printed circuit board.

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~~7~~. (Original) A method as in claim 8 ~~2~~ wherein said object is a liquid photopolymer.

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~~8~~. (Currently Amended) A method of projecting images from a ~~two-dimensional~~ two-dimensional light valve onto a continuously moving object, said light valve generating a rapid sequence of stationary images, said method

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comprising placing a scanning element between said light valve and said object, said scanning device making each one of said stationary images appear stationary relative to said moving object.

6
9. (Currently Amended) A method as in claim 1 wherein said scanning ~~device~~ element is a galvanometer driven mirror.

7 6
10. (Currently Amended) A method as in claim ~~9~~ wherein said galvanometer includes provisions for electronically controlling scan linearity.

Cont'd

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11. (Currently Amended) A method as in claim ~~8~~ wherein said scanning element is a galvanometer driven mirror and said galvanometer includes provisions for electronically controlling scan linearity.

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12. (Original) A method as in claim ~~8~~ wherein said object is a printing plate.

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13. (Original) A method as in claim ~~8~~ wherein said object is a printed circuit board.

14. (Cancelled)

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REMARKS

Specification

The Specification has been amended for clarity and to remedy a number of typographical errors. The Applicant submits that the amendments to the Specification add no new subject matter.

Claims

The Applicant has cancelled claim 14. Claims 1-13 are currently pending.

The Examiner has indicated that claims 1-9 and 11-13 are allowed. The Applicant has made a number of minor typographical amendments to claims 1, 2, 8, 9 and 11. These typographical amendments are submitted not to alter the scope of the claims in any way. Accordingly, claims 1-9 and 11-13 are submitted to be in condition for allowance.

The Examiner has expressed the view that claim 10 did not conform with 35 USC § 112 because it failed to disclose the claim from which it depends. Claim 10 has been amended to depend from claim 9. The Applicant submits that claim 10 is now in condition for allowance.

Conclusions

The Applicant submits that this application is now in condition for allowance and respectfully requests reconsideration and allowance of this application in light of the foregoing amendments and comments.

Respectfully submitted,
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